Effect of Slope Squat on Lower-Extremity Muscle Activity

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Introduction
◆ Squat is a common multi-joint close-kinetic exercise used by clinicians and sport coaches to strengthen the lower-extremity (LE) muscles and enhance the posture and balance control of the lower limb (Ceaglio et al. 2010).
◆ During squat, cross-joint muscles (quadriceps, hamstrings, and gastrocnemius) contract to produce shear and compressive forces that may need to be controlled as part of a rehabilitation program. Excessive shear and compressive forces at the knee are the main risk factors for injuries during squatting (Escamilla 2001).
◆ Squatting on a decline slope might reduce the load on the knee joint by reducing LE muscle activation compared to level squat. Therefore, this study aimed to explore the effects of a decline surface on LE muscle activity during double-leg squats in healthy subjects.

Method
◆ Fifteen participants (age 24.5 ± 3.2 years) performed five squats on both 5-degree slope and level ground.
◆ Surface electromyography (EMG) was recorded from three muscles of the dominant leg: rectus femoris, biceps femoris, and gastrocnemius.
◆ Participants were instructed to squat to a depth at which their thighs were parallel to the treadmill surface, which is around a 70-degree squat.
◆ A GoPro camera recorded the squat performance, and the peak knee joint angle (PKJA) was measured by Kinovea software.

Results
◆ There was no significant difference in PKJA between squats on a 5-degree slope and on level ground (70 ± 2.6° and 72 ± 4.6° respectively, P = 0.095), which laid a valid foundation for the muscle activation comparison.
◆ The comparison of muscle activity at PKJA between 0-degree and 5-degree squat is presented as table and graph below (Table 1, Figure 1).
◆ For biceps femoris, muscle activity at PKJA was significantly lower on 5-degree slope than on level ground (54 ± 36.4 μV and 60 ± 32.9 μV respectively, P = 0.016).
◆ For rectus femoris and gastrocnemius, there was no significant difference in muscle activity at PKJA (P = 0.15 and P = 0.074 respectively).

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean peak RMS EMG (μV)</th>
<th>Standard deviation peak RMS EMG (μV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectus femoris</td>
<td>157</td>
<td>62.7</td>
</tr>
<tr>
<td>5-degree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biceps femoris</td>
<td>54</td>
<td>36.4</td>
</tr>
<tr>
<td>5-degree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td>29</td>
<td>16.2</td>
</tr>
<tr>
<td>5-degree</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Descriptive statistics of EMG data

Figure 1. Comparison of muscle activity across conditions. Error bars represent standard deviation.

Discussion & Conclusions
◆ The activity of biceps femoris at PKJA was less when a squat was performed on a 5-degree decline than on level ground.
◆ In clinical rehabilitation, patients with knee injury who have LE muscle weakness may benefit from performing squats on a decline surface, because slope squat requires less hamstring muscle activity at PKJA.

References